Image Intensifier Screen

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[redacted]

| 4.1 GAIN → 1 cdl/Ft² ⇒ 50 L/Ft² | 4.2.1 BRIGHTNESS 50 L/Ft² MAX w/ 200 AS A GOAL | 4.2.2 LINEARITY GAMMA APPROX unity (± 10%) | 4.2.3 BRIGHTNESS VARIATION | 4.2.4 BRIGHTNESS DISTRIBUTION LOBE | 4.2.5 COLOR TEMPERATURE (3500° - 5500° K) | 4.2.6 BRIGHTNESS LEVELS (10 - 20) | 4.2.7 REFLECTANCE | 4.3 RESOLUTION 90% m. 10 ll/mm with contrast of 100:1 & 1 |
|---|---|---|---|---|---|---|---|---|
| 50 appears reasonable. (100 has been obtained with the new CdSe - EL)<br>200 for short duration | 50 appears reasonable. (a new [redacted] EL material is capable of 100 L/Ft² with a half-life of 2000 hrs) | needs investigation<br>GAMMA requirements CAN be meT. | needs investigation<br>ditto | needs investigation<br>Requirements can be met | possible anywhere in the visible spectrum. Green is best.<br>P-20 yellow phosphor preferred. | difficult to predict<br>< 15 gray steps of $\sqrt{2}$ is achievable. 20 levels would need investigation | 0% reflectance impossible, but can be minimized to a suitable level.<br>ditto | the most difficult to achieve. beyond state-of-the-art - suggest a change in geometry.<br>cannot achieve; at 10 ll/mm the amplitude response would be between 10% & 30% |
| N C | If evaporated film type is used 50 foot lamberts is not now attainable except for short periods of time | one of the fundamental problems. light output of powder phosphors varies as the cube of the current. Photoconductors with finer control not available. Evaporated film type P.C. have better linearity but with low max. brightness. | uniformity of brightness is very difficult on evaporated film P.C. due to preparation problems | N C | N C | N C | N C | the necessary thickness of photoconductors causes spreading of the current with resultant loss of resolution. |
| N C | 10 foot lamberts is currently achievable. | a major problem. Gamma is variable and is a function of almost every operating parameter plus material preparation. | N C | N C | N C | N C | N C | resolution of the grooved types is limited to ≤ 2 ll/mm & < 4 ll/mm for the parallel wire type of [redacted] et al. |
| | 50 ft. lamberts proposed<br>20 ft lamberts now available<br>1000 ft lamberts capable at low duty cycle | unity gamma over a 100:1 brightness variation | 100:1 | NC | white | > 12 | minimized by use of Transparent EL phosphor | > 10 ll/mm |
| | | | | | | | | |
| | | | | | | | | |
| nel amplifiers<br>tate-of-the-art - No interest<br>no interest. | | | | | | | | |
| | | | | | | | | |

| 4.4. RESPONSE TIME .001 sec. 90% within 10 m/sec. & fall below 10% in $10^{-3}$ | 4.5 S/N RATIO no less than 100 | 4.6 SIZE 6x6 + 12x12 | 4.7 LIFE EXPECTANCY 200 hrs. | 4.8 POWER REQUIREMENTS | 5.1.1 INTENSITY REVERSAL | 5.1.2 BRIGHTNESS RANGE COMPRESSION & EXPANSION | 5.2. MONOCHROMATIC SENSITIVITY | General Comments. |
|---|---|---|---|---|---|---|---|---|
| depends on level of illumination. best now is 90% of full brightness in .04 seconds.<br>requirements can be met | no comment<br>100 can be met | not a limiting factor which size?<br>12"x12" can readily be developed<br>30x30 will require considerable work | half life of 2000 hrs<br>no comment | no problem<br>no comment | not possible<br>no comment | not possible<br>no comment | possible at 6328Å<br>UV not possible<br>no comment | |
| N C | N C | N C | on evaporated phosphor film, 200 hrs. is not attainable at a 50 foot lambert brightness level. | on evaporated film, power required is high + resultant heating of the intensifier | N C | N C | N C | a research effort rather than a development effort |
| N C | N C | a major problem. | N C | N C | N C | N C | N C | interested in channel amplifiers |
| .05 seconds | 100:1 is expected | 12"x12"<br>upper limit are determined by capacitance & power consumption<br>30"x30" is possible | 500 hrs half life | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

30-100 MC

5000 PHOTODIODES/INCH

1/25 LIGHT NEEDED
AS CONV. VIDICON
BUT LOOSE 1/6 SENSITIVITY

ORDER OF IMPORTANCE
1. PHOTO DIODES
2. " TRANSISTORS
3. INTERGRATING P.D.
MOST IMP. 4. " P.T.

By providing an output that represents both the amount and position of light on its surface, an experimental unit may extend the use of optical scanning in remote data collection terminals as well as simpler, less expensive central scanning installations.

# EXPERIMENTAL SOLID-STATE SCANNING DEVICE

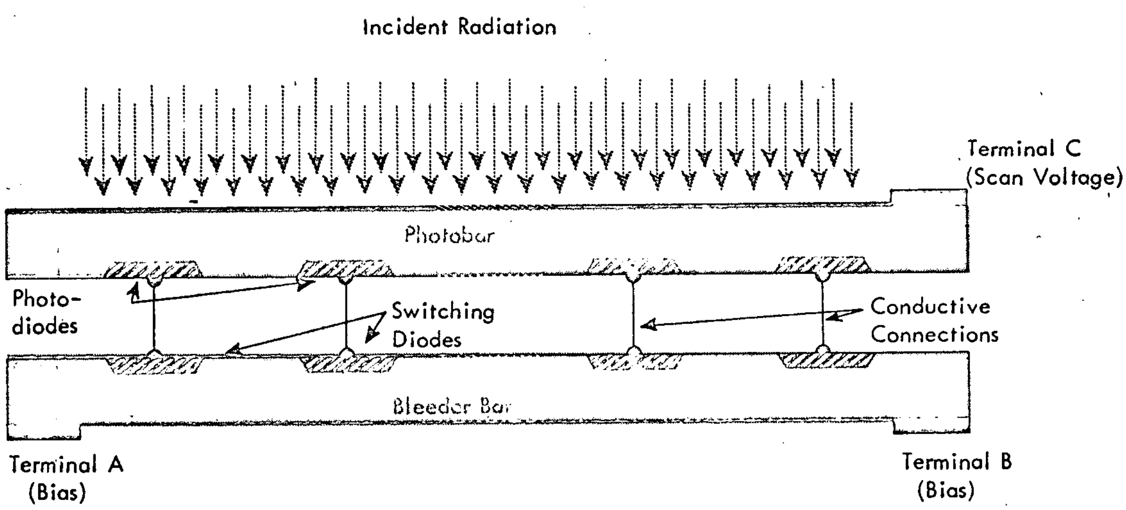


Fig. 1. Two bars of germanium, silicon, or other semiconductor material form the Scanistor's top and bottom surfaces. These are the photobar and bleeder bar shown in the drawing. Dots of opposite type (P or N) semiconductor, alloyed or diffused into the inner surfaces of the bars, form diodes which are connected in pairs. One diode in each pair acts as a photodiode to measure the light intensity on that part of the Scanistor. The other diode is a switching diode which connects its photodiode to the output circuit at a particular value of scanning voltage. Scanistors can be fabricated in a wide range of sizes, shapes, resolutions, and spectral sensitivities. Sensitivity depends on the materials of which the Scanistor is made, the scanning speed, and the wavelength of the radiation being sensed. The sensitivity of experimental silicon photodiode Scanistors is equivalent to that of a good silicon photocell. These Scanistors give an output of 0.5 ampere per watt of incident light with a wavelength of 9,000 angstroms. For very low light applications, an experimental super-sensitive Scanistor has been developed which makes use of the greater sensitivity of photoconductive materials. This version substitutes photoresistors made of materials such as cadmium sulphide for the photodiodes. IBM silicon Scanistors are sensitive to visible and near infrared radiation with wavelengths between about 4,000 and 11,000 angstroms. Other units, designed especially for best response to near infrared radiation might employ indium antimonide photodiodes or lead sulphide photoresistors. By choosing suitable materials, other Scanistors could be made sensitive to far infrared or even to x-rays. Scanistor response rates of several million resolvable elements per second have been demonstrated in the laboratory. For example, units with 75 diode-pairs have been operated successfully with scan durations as short as 10 microseconds.

An experimental solid-state optical scanning device which converts images into electrical signals has been developed by IBM Corp. The dime-size device, called the Scanistor, combines high resolution and fast response with other advantages of solid-state electronics — low power operation, small size and weight, long life, and simple circuitry.

The Scanistor differs significantly from earlier solid-state light-sensitive devices such as the photocells used in electric-eye cameras. Because these cells sense only the total amount of light falling on their surface, detecting a pattern requires many cells, arranged in-line or in a mosaic pattern, and a corresponding number of output amplifiers.

In contrast, the Scanistor provides, on a single output wire, an analog voltage that represents both the amount and position of light shining on its surface. Or, with different operating voltages, the Scanistor can provide a series of corresponding electrical pulses for entry into a digital computer. The construction of the Scanistor and its operation are described in Figs. 1 and 2. A photo of the device is shown in Fig. 3.

All of the Scanistors built to date have been one-dimensional, detecting the light pattern along a single line such as one scan line of a television picture. However, there are several ways that the Scanistor concept could be extended to detect a two-dimensional image such as a whole television picture.

In reading punched cards or tape, or printed documents, it is possible to move the image itself past the Scanistor to provide a complete scan of the image area. For example, IBM has experimented with a simple Scanistor system which converts typed text into electrical signals and displays the text on a TV-like screen. In this experiment, a card carrying a line of text is mounted on a rotating drum beneath a single-line Scanistor. Then, as the characters are swept past the Scanistor by drum rotation, the Scanistor electronically scans them from top to bottom.

To scan a stationary image, a moving mirror can be used to reflect the image, line-by-line, onto a Scanistor. Another approach is to mount

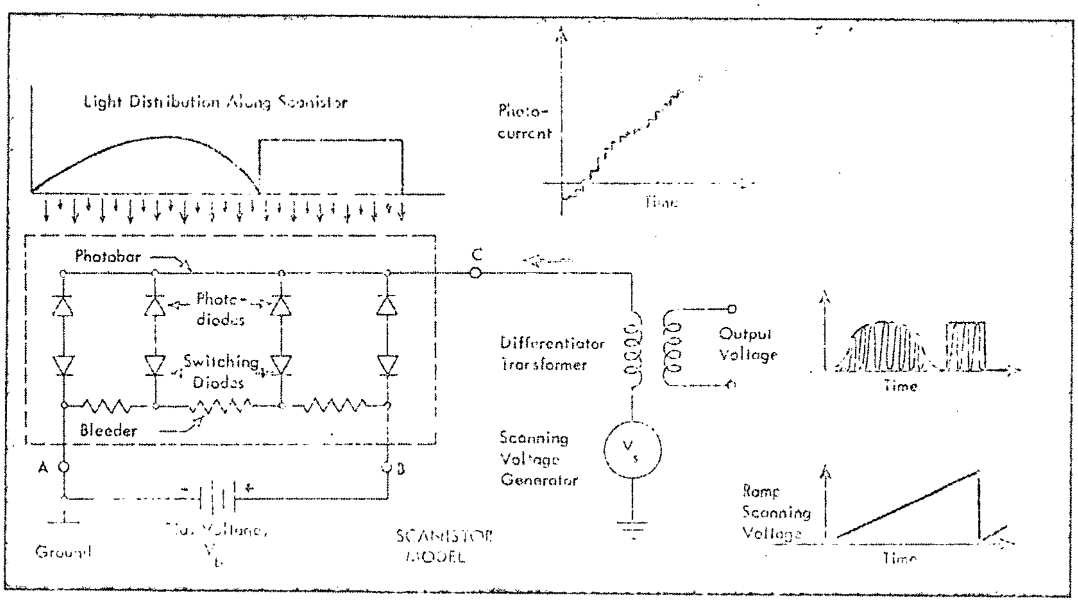


**Fig. 2. A Scanistor can be thought of as a row of back-to-back diode-pairs, arranged so that one end of each pair is connected to a conducting "photobar", and the other end is connected to a resistive "bleeder". The diodes connected to the photobar act as photodiodes and receive light from an image projected onto the upper surface of the Scanistor. The diodes connected to the bleeder act as blocking, or switching, diodes to control the scanning of the image. Two terminals attached to the ends of the bleeder receive a fixed bias voltage $V_b$ (typically six volts). The bleeder acts as a voltage divider, and each blocking diode is returned to a different voltage, ranging from zero to $V_b$. A third terminal attached to the photobar receives a scanning voltage $V_s$. Electronic scanning is performed by making $V_s$ a linear ramp voltage that increases at a constant rate from zero to the value of $V_b$. At the start of a scan, when the scanning voltage is zero, all of the blocking diodes are reverse-biased by the bias voltage, and only a small leakage current flows through them. But as the scanning voltage increases, the blocking diodes are forward-biased for easy conduction, one after another. As each additional blocking diode is switched on by the scanning voltage, the amount of additional current flowing through it from the photobar to the bleeder depends on that state of the associated back-biased photodiode. The leakage current through this diode is proportional to the amount of light falling on its active surface. Thus the amount of additional current switched between the photobar and the bleeder depends on the amount of light falling on that part of the Scanistor. Since it is the change in current that is proportional to the light, the photobar current is passed through a differentiator circuit which can be a series inductor or transformer. With relatively large values of bias voltage $V_b$, the output from the differentiator is a series of pulses, the height of each being proportional to the light on one of the photo-diodes. Lower values of $V_b$ give a smooth output voltage representing the light distribution along the Scanistor.**

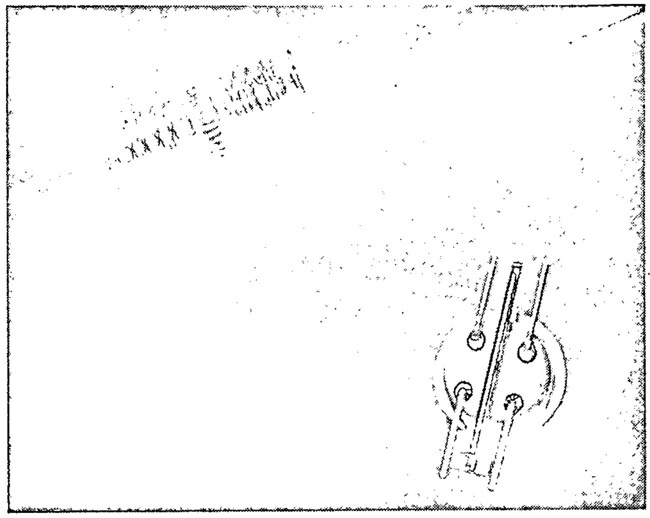

**Fig. 3. The Scanistor shown here is one-half inch long, and contains 100 light-sensitive diodes paired with 100 switching diodes. These diode-pairs are spaced 0.005 inch apart to give a resolution of 200 image elements per inch.**

several Scanistors side-by-side and combine their outputs into one picture.

IBM engineers believe it may eventually be possible to fabricate a folded Scanistor that provides a TV-like raster scan, or a mosaic Scanistor that scans in two directions at once.

To illustrate one approach to a character recognition application, eight Scanistors have been assembled into a special pattern to recognize constrained handwriting — both numbers and letters. For reading, cards on which characters have been written are fed into a converted card punch machine which projects each character image onto the Scanistors. Characters are recognized by determining which Scanistors their image intersects.

IBM engineers believe that Scanistors could also be used in other types of character recognition machines that scan the entire text area or trace out character patterns. With simple Scanistor scanners to convert printed or handwritten characters into electrical signals, one set of recognition logic at a central location could serve many input terminals in remote locations.

IBM Scanistors made of silicon are sensitive to both ordinary light and near infrared radiation. Similar units fabricated from other semiconductor materials could be made sensitive to far infrared, thus overcoming a limitation of vacuum tube scanners, as orthicons and vidicons.

Although the Scanistor is experimental and not commercially available, IBM has tested sample units in such applications as document and film scanning, character recognition, and reading punched and mark-sense cards.

Looking ahead, here are a few of the possible future uses for Scanistors that IBM engineers have suggested:

- A hand-held "reading" device which could be passed over a line of printed text to enter data into a computer
- Small remote terminals at which information could be written directly into a data processing system
- A simple position sensor requiring no standby electrical power to relay the readings of thermometers or other instruments to a central location
- A memory read-out device for mass memories which store information in the form of optical patterns
- Compact, infrared scanners for battlefield surveillance.

END

REQUEST FOR PROPOSAL on Image Intensifier Screen

The technical proposal should include at least the following items:

A. A response to each of the parameters listed in sections 4 and 5 of the attached Development Objectives. These responses should include:

1. The relative feasibility of achieving the stated requirements of each of these parameters,

2. compatibility, relationships and trade-offs with other parameters;

3. your technical approach to achieve the design goals of each parameter.

B. Since an image intensifier screen has high priority in our development program it is highly desirable to contract for an accelerated development schedule. Your proposal should indicate the shortest possible development time consistent with the most efficient utilization of the development staff. Your proposal should reflect a three-phase effort as follows.

Phase I - Proof of Feasibility proof should be experimentally demonstratable on a breadboard 6 x 6 panel and substantiated be a comprehensive report.

Phase II - Delivery of a 12 x 12 panel which complies with the objectives.

Phase III - Delivery of a 30 x 30 image intensifier screen which meets all of the required specifications.

We anticipate a one year contract. It would be highly desirable to accomplish all three phases within that period if it is feasible with available scientific talent. Your proposal should indicate a program schedule which depicts development times for each of the three phases. Your proposal should also indicate a budget cost for each phase.

C. A proposed project organization should be included in your proposal. This should reflect your available facilities for this project, management of the project, and personnel to staff the project.

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